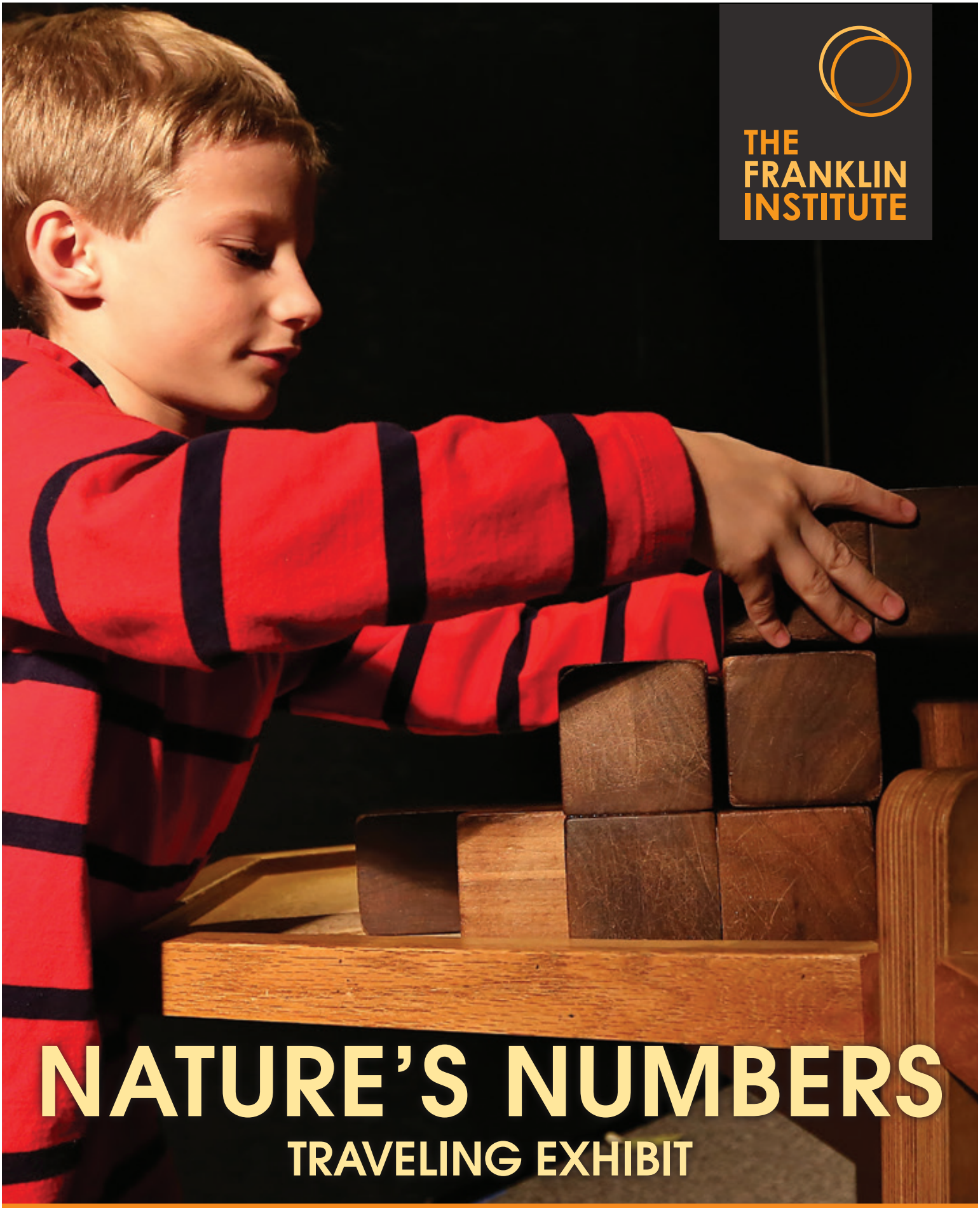


THE FRANKLIN INSTITUTE

NATURE'S NUMBERS

TRAVELING EXHIBIT

K-12 EDUCATOR'S GUIDE

WHAT IS SYMMETRY?

WHERE DO WE SEE PATTERNS IN NATURE?

HOW DO WE USE MATH TO UNDERSTAND NATURE?

The “Nature’s Numbers” exhibit invites you and your students to consider these questions and find answers.

DURING YOUR VISIT, STUDENTS WILL:

- Interact with devices that invite them to explore symmetry.
- Look for recurring patterns in nature.
- Explore how mathematics helps us to understand the natural world.

AFTER YOUR VISIT, STUDENTS WILL:

- Understand the relationship between patterns and math.
- Know how to look for patterns in nature.
- Better appreciate the role of mathematics in everyday life.

EXHIBIT OVERVIEW

The pattern of spots on your dog, the delicate symmetry of butterfly wings, the angular shapes of crystals, and the ruggedness of a coastline all involve math. “Nature’s Numbers” helps students understand the connections between math and nature with concrete, hands-on interactive exhibits.

Symmetry, fractals, and Fibonacci numbers are among the classic mathematical concepts that students will explore during their visit.

The exhibit features four key themes. Repeating Patterns explores patterns found in nature. Shapes and Sizes offers opportunities for children to discover and become familiar with shapes found in nature. Designs in Nature relates natural formations specifically to math. And finally, by asking visitors to solve nature’s puzzles, we create a natural foundation for Mathematical Inquiry.

Encourage your students to discuss the many ways they use math every day. Help them see the relevance of the exhibit content to their everyday lives.

REPEATING PATTERNS

Circle of Symmetry
Where are the patterns in a butterfly’s wing? Students rotate a patterned disc mounted to a butterfly’s wing to see the patterns align and mix.

Repeating Patterns
What is special about the symmetry of a snowflake? “Koch’s” snowflake is based on fractals—geometric shapes that repeatedly subdivide, each becoming a smaller copy of the whole. Encourage your students to experiment with making fractal snowflakes.

Spirograph
Like the toy we all used as children, students can make a repeating pattern that looks like one you may see in a flower or another part of nature.

Wild Weather
If you start two pendulums in the same place they will start to swing in the same way but quickly have diverging patterns. Weather works in the same way and is therefore hard to predict.

Covering a Square
Do you see the pattern of halves? The largest piece fills half the square, the second largest covers half as much as the first and so on. No matter how many times you add pieces that are half the size of the previous one, you will never cover the entire square.

SHAPES AND SIZES

Rainbows of Light
A table surface with prisms and light allows students to explore the properties of light and color.

Shape Wheel
Are all the shapes the same size? Turn the wheel and make the beads flow from one shape to another. They may appear to be different at first, but they all actually have the same area.

Touch Bumps
Nature's patterns are not only seen, they can be felt too. Close your eyes and touch the different textured patterns.

Tangram Zoo
Tangram puzzles allow students to create something beautiful out of simple shapes. This puzzle is similar to two-dimensional origami. Assembled, the puzzles make silhouettes of animals.

Section
A long block of wood is made up of only rectangles and squares, correct? Looking at cross sections, students can find shapes they never expected to find.

DESIGNS IN NATURE

Logarithmic Spiral
Can you replicate the pattern found in a nautilus shell? Many things in nature follow a similar logarithmic spiral.

Kiddie Kaleidoscope
Young students can play with colorful pieces of nature seeing the reflections of these shapes and themselves, like a Kaleidoscope.

Rosette Kaleidoscope
A pattern is a pattern is a pattern—or is it? By opening and closing two mirrors that are reflecting an image of a natural object, students change the reflected patterns they see.

Balancing Act
Five wooden blocks are assembled into an overhanging series of cantilevers, which results in the uppermost piece being completely outside of the shelf on which the blocks are assembled.

Voussoir Arch
Gravity helps nature build an arch. Students use keystone-shaped blocks and gravity to make their own arch.

Reflections
Symmetrical patterns are everywhere in the natural world. Students make reflections of their hand in a kaleidoscope showing new patterns with three fingers or ten fingers on one hand.

MATHEMATICAL INQUIRY

Question Du LapIn
Students will enjoy solving this classic puzzle of five octagons with cutout silhouettes of animals. When the pieces are placed on top of one another in the right orientation, the shape of a rabbit silhouette can be seen in the assembled negative space.

Tetrahedron Topple
What do you get when you combine four tetrahedrons and two pyramids? Students will find out by putting the pieces together themselves.

Cubism
This traditional puzzle challenges students to make a large cube from seven pieces made up of smaller cubes. Students will be surprised to find that there are a number of ways it can be accomplished.

Towers of Hanoi
This classic puzzle features seven disks, each of smaller size, and three poles. Students must follow the precise rules to move the complete stack from one pole to another.

Leafy Pieces
Students are challenged to solve a classic, complicated, 3-D jigsaw puzzle of a leaf.

TRY THIS!

For Younger Students

MAKING PATTERNS

The “Nature’s Numbers” exhibit offers several opportunities for students to learn about patterns and how shapes fit together. This activity encourages an interdisciplinary exploration of mathematics through art.

Supplies:

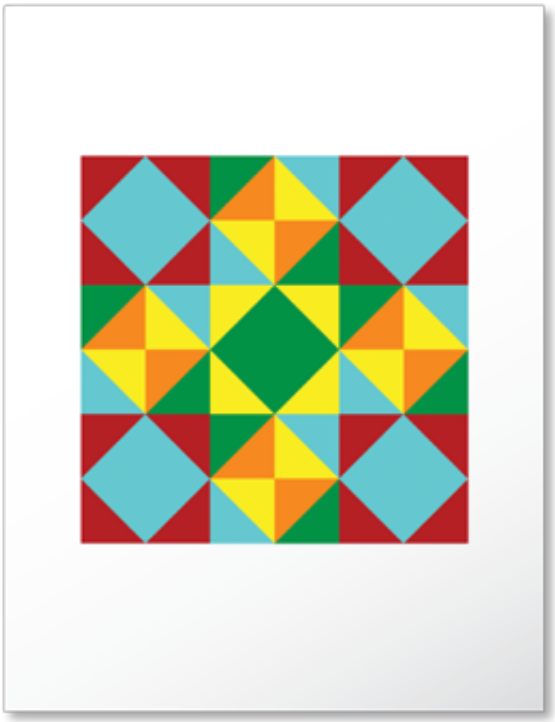
- Construction paper: one full-size sheet per student
- Smaller, pre-cut paper squares and triangles in a variety of colors
- Gluesticks

To Do:

Each student will use one full-size sheet of paper as a canvas.

Have students create a pattern using the pre-cut squares and triangle. Glue the pattern to the canvas.

Older students may cut their own squares and triangles. The size of the squares and triangles can vary by age. For the youngest children, squares might be 2” x 2”. For older children, squares could be as small as .5” x .5”. After cutting the squares, cut diagonally to make the triangles. The smaller the shapes, the more complex the patterns can be.



TRY THIS!

For Older Students

FIBONACCI ART

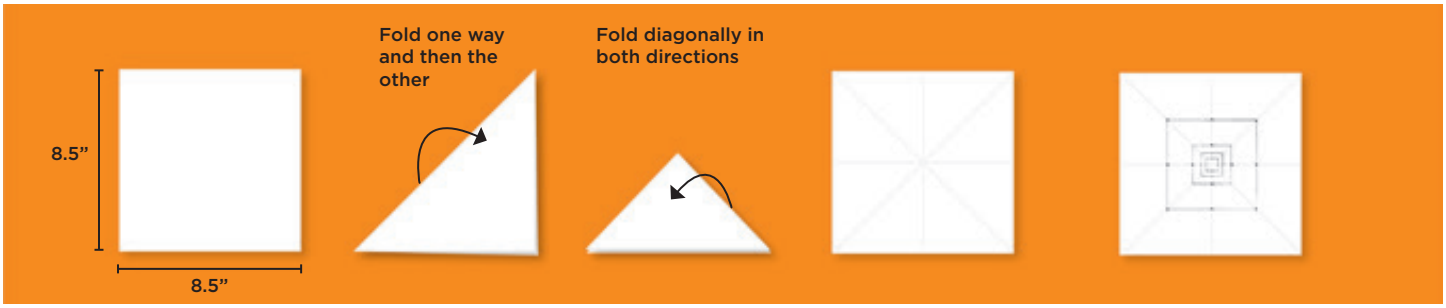
The “Nature’s Numbers” exhibit introduces students to the concept of Fibonacci numbers. This activity encourages an interdisciplinary exploration of mathematics through art.

Supplies:

- One 8.5” x 8.5” square sheet of white paper per student
- Scissors, ruler, colored pencils

To Do:

Each student needs an 8.5” x 8.5” square sheet of white paper. You can pre-cut the sheets or have the students trim an 8.5” x 11” sheet to square.



Crease the square four times. Begin by folding in half one way, then the other. Then, fold diagonally in both directions. Open the square and you should have four intersecting creases meeting in the center of the square.

Use the ruler to find the halfway points from the outer edges along each crease. Draw lines to connect the points. Repeat, working into the center until you have a series of four concentric squares.

Use colored pencils to “fill in” one of the smallest triangles in the center. Then shade in one of the large triangles touching it. Continue in the same directions, shading larger triangles until you reach the outside of the paper.

Your design will reveal how the mathematical squares become the basis for beautiful repeating patterns.

SUGGESTED RESOURCES FOR K-12 CLASSROOMS AND LIBRARIES

Elementary School

Grandfather Tang's Story
by Ann Tompert
ISBN 0517885581

The Math Book for Girls:
And Other Beings Who Count
by Valerie Wyatt
ISBN 1550745840

Nature's Paintbrush:
The Patterns and Colors Around You
by Susan Stockdale
ISBN 0689810814

Middle School

Building Big
by David Macauley
ISBN 0618465278

Growing Patterns
by Sarah C. Campbell
ISBN 1590787528

Life by the Numbers
by Keith Devlin
ISBN 0471240443

High School

Designing Tessellations:
The Secrets of Interlocking Patterns
by Jinny Beyer
ISBN 0809228661

The Golden Section: Nature's Greatest Secret
by Scott Olson
ISBN 0802715397

Websites

www.snowcrystals.com
Some of the most beautiful natural math is seen in snowflakes.

www.mathsisfun.com/numbers/fibonacci-sequence.html
Designed with teachers in mind, this site offers a clear overview of the Fibonacci sequence.

CURRICULAR STANDARDS

An exploration of the “Nature’s Numbers” exhibit can help students achieve learning objectives as called for by national standards.

Next Generation Science Standards

3-5: Engineering Design
MS: Engineering Design
HS: Engineering Design

Common Core English Language Arts

K-5: Reading Informational Text
6-12: Literacy in Science & Technical Subjects

National Science Education Standards

K-4 B: Physical Science
5-8 B: Physical Science

Common Core Mathematics

K-12: Measurement & Data

Benchmarks for Science Literacy

2. The Nature of Mathematics
2a. Patterns & Relationships
2b. Mathematics, Science, & Technology

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The Franklin Institute
222 North 20th Street
Philadelphia, Pennsylvania 19103
www.fi.edu